

**APPLICATION FOR UNITED STATES LETTERS PATENT**

**INVENTORS:**

**TITLE:     IMAGE CONVERTING APPARATUS AND METHOD THEREOF**

**ATTORNEYS:     FLESHNER & KIM, LLP**  
**&     P. O. Box 221200**  
**ADDRESS:        Chantilly, VA 20153-1200**

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# IMAGE CONVERTING APPARATUS AND METHOD THEREOF

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

[1] The present invention generally relates to processing images, and more particularly to a system and method for converting a color image of a first bit size into a color image of a second bit size.

### 2. Background of the Related Art

[2] In the related art, a pallet has been developed to indicate color information for an 8-bit image. Accordingly, when a color value of a pixel of an 8-bit color image is calculated, a red/green/blue (RGB) value can easily be read from the pallet only by using an index value. However, unlike an 8-bit image, no pallet concept has been developed for expressing color information in a 16-bit image. This is because 16-bit images are expressed using 2 bytes and because a pixel itself has color information. Thus, RGB values corresponding to pixels in a 16-bit image have to be obtained through calculation. The method used to calculate RGB values for a 16-bit image can differ depending upon the type of image conversion method.

[3] When a 24-bit image is converted to a 16-bit image supported by a mobile communication terminal, in order to allocate RGB values for each of the pixels of the 24-bit image to the 16-bit image evenly, the color value for each pixel in the 24-bit image is divided by 3, and five bits are then allocated for each of the RGB colors in the 16-bit image and one bit remains unused. More specifically, two 16-bit color display methods have been proposed

in the related art which involve converting a 24-bit image into a 16-bit. These methods are the 5:5:5 method and the 5:6:5 method.

[4] Figure 1 shows how an image converting process is performed using the 5:5:5 method. In converting an 8-bit RGB value into a 16-bit RGB value, 5 bits are allocated to each of the R, G, B colors and the remaining 1 bit is not used. More specifically, 8-bit RGB values in respective shifters 111-113 are stored in a memory 114 as 5-bit values, and the remaining 1 bit (represented as the leading “0” bit) is not used.

[5] In the 5:5:5 method, color values are calculated as follows. When there are RGB colors, RGB values are represented by 5 bits each, which means that a loss of 3 bits occurs for each color in the 24-bit image. This may be described as  $R_{16}=R/8$ ,  $G_{16}=G/8$  and  $B_{16}=B/8$ . After calculating 16-bit color, the R value stored in shifter 111 is shifted towards the right 3 bit positions and the remaining R bits are output to register 114, which is shifted toward the left to the 10<sup>th</sup> bit position. The G value stored in register 112 is shifted towards the right 3 bit positions and the remaining G bits are output to register 114, which is shifted toward the left to the 5<sup>th</sup> bit position. And, the B value stored in register 113 is shifted towards the right 3 bit positions and the remaining B bits are output to register 114. Accordingly, a 16-bit RGB value is obtained in register 114 with a 0 value inserted into the 16<sup>th</sup> bit position.

[6] Figure 2 shows how an image converting process is performed using the 5:6:5 method in accordance with the related art. First, 8-bit RGB values are converted into a 16-bit RGB value, by respectively allocating 5 bits to each of the R, G and B values. The remaining 1 bit is unconditionally allocated to the G value at all times. This extra bit

allocation is performed because the eyes of a human being classify green color well. Therefore, providing the extra bit to the green color ostensibly helps in this regard.

[7] Unlike the 5:5:5 method, in the 5:6:5 method, the R and B values respectively lose 3 bits but the G value loses 2 bits. The R and B values therefore have a start bit different from each other. More specifically, when there are RGB colors, R and B respectively have 5 bits and G has 6 bits. This may be described as  $R_{16}=R/8$ ,  $G_{16}=G/4$  and  $B_{16}=B/8$ .

[8] After calculating a 16-bit color as a combined 16-bit RGB value for each pixel, the R value in register 211 is shifted towards the right 3 bits and the remaining R bits are output to register 214, which is shifted towards the left to the 11<sup>th</sup> bit position. The G value in register 212 is shifted towards the right by 2 bits and the remaining G bits are output to register 214, which is shifted towards the left to the 5<sup>th</sup> bit position. And, the B value in register 213 is shifted towards the right by 3 bits and the remaining B bits are output to register 214. Accordingly, a 16-bit RGB value is obtained in register 214.

[9] In the 5:5:5 method of the related art, by wasting 1 bit, more color information of an actual image is lost. And in the 5:6:5 method, 1 more bit is unconditionally allocated to the G value than to the R and B values, thereby emphasizing the G color more than an actual color. As a result, the image may be converted into an image which is generally similar to a C color. A need therefore exists for a system and method which more accurately and efficiently represents color information in a converted color image, including but not limited to 16-bit color images which have been formed as a result of a conversion process from a 24-bit color image.

## SUMMARY OF THE INVENTION

[10] An object of the invention is to solve one or more of the problems of the related art discussed above.

[11] Another object of the present invention is to provide a system and method for more accurately representing color information in a converted color image compared with related art methods.

[12] Another object of the present invention is to achieve the aforementioned object by more efficiently converting M-bit color information into N-bit a color information.

[13] Another object of the present invention is to achieve the aforementioned object when  $M > N$ .

[14] Another object of the present invention is to provide an image converting apparatus and a method which minimizes color information loss in the exemplary case of when 24-bit RGB image data is converted into 16-bit image data. The converted 16-bit image data may then be displayed on any suitable device including but not limited to a mobile communication terminal in a manner substantially similar to an actual image. In accordance with one embodiment, this is accomplished by determining which of a plurality of colors in the 24-bit image has a predetermined specific gravity relative to the other colors and then allocating at least one extra bit to represent that color in the conversion process. The predetermined specific gravity is preferably a comparatively greater specific gravity among the RGB colors.

[15] To achieve these and other advantages, the apparatus of the present invention includes in one embodiment an RGB dividing unit for dividing a 24-bit color image into 8-

bit RGB values on a per-pixel basis; a comparing unit for judging a color having a comparatively greater specific gravity by calculating a color value of each 8-bit R, G, B; a shift unit for shifting each 8-bit R, G, B in order to allocate more pertinent color bit to the color having the comparatively greater specific gravity; a combining unit for generating a 16-bit image by combining the shifted each R, G, B; and a video memory for storing the generated 16-bit image.

[16] An embodiment of the method of the present invention includes dividing a color image into RGB values, judging a color having a predetermined (e.g., comparatively greater) specific gravity after calculating each of the RGB color values, comparing the color values, allocating at least one extra bit to represent the color having the comparatively greater specific gravity, and combining bit-allocated RGB values to form the converted image.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

[17] Figure 1 is a view illustrating a related-art process for performing 5:5:5 color image conversion;

[18] Figure 2 is a view illustrating a related-art process for performing 5:6:5 color image conversion;

[19] Figure 3 is a block diagram illustrating an image converting apparatus in accordance with one embodiment of the present invention; and

[20] Figures 4-6 are exemplary views illustrating image converting processes in accordance with preferred embodiments of the present invention.

## DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[21] Figure 3 is a block diagram illustrating an image converting apparatus in accordance with one embodiment of the present invention. The image converting apparatus includes an RGB dividing unit 310 for dividing a 24-bit color image into respective 8-bit RGB color values per pixel, a comparing unit 320 for judging a color having a comparatively greater specific gravity, and a shift unit 330 for shifting each of the 8-bit R, G, B values for each pixel in order to allocate one or more additional color bits to the color having the comparatively greater specific gravity. A combining unit 340 then generates a 16-bit color image by combining the shifted R, G, B values and a video memory 350 stores the generated 16-bit image.

[22] Operation of the image converting apparatus in accordance with the present invention will now be described. First, the RGB dividing unit 310 divides a 24-bit color image received from an external source into respective 8-bit R, G, B color values for each pixel using one of a variety of known techniques.

[23] The comparing unit 320 judges which one of the three colors has a comparatively greater specific gravity than the other colors. This involves calculating a color value for each of the 8-bit R, G, B images generated by the RGB dividing unit 310 and then comparing the color values. For example, a given pixel in the 24-bit image may have a red color value of 127, a green color value of 221, and a blue color value of 64. These values may be measured on a scale similar to a grayscale, where color shades are represented as values ranging from 0 to 255. The color having the greater specific gravity may be selected as the one with the greater color value, which in this case is the green color. Those skilled in the art

can appreciate that other known methods of determining the specific gravity of colors in an image may be used in lieu of the exemplary technique just described.

[24] Next, in order to allocate more bits to the color having the comparatively greater specific gravity and to allocate a lesser number of bits to each of the remaining two colors, the shift unit 330 respectively shifts the 8-bit R, G, B values for each pixel. The combining unit 340 then generates a 16-bit image by combining the shifted R, G, B values on a pixel-by-pixel basis. Each pixel in the converted 16-bit image is therefore given a color value wherein 6 bits are allocated to the color having the comparatively greater specific gravity and 5 bits are allocated to each of the remaining two colors.

[25] Next, the generated 16-bit image is stored in the video memory 350 and is transmitted to a display apparatus (not shown). Accordingly, an image similar to an actual image can be displayed.

[26] As described above, after judging the color having the comparatively greater specific gravity, the process for generating a 16-bit image by allocating one bit more to the color having the comparatively greater specific gravity will be described in detail with reference to accompanying Figures 4-6. First, a case in which 8-bit R has a comparatively greater specific gravity will be described.

[27] Figure 4 is an exemplary view illustrating an image converting process when R has a comparatively greater specific gravity. When R has a comparatively greater specific gravity, the 8-bit RGB values for each pixel in the 24-bit image is converted into a combined 16-bit RGB value, with the extra 1 bit allocated to the R value. This may be described as  $R_{16}=R/4$ ,  $G_{16}=G/8$  and  $B_{16}=B/8$ .



[28] More specifically, the combined 16-bit color value is formed by shifting R value in register 311 toward the right by 2 bits and then outputting the remaining 6 R bits to register 314. To accomplish this, register 314 is shifted toward the left to the 10<sup>th</sup> bit position. Then, the G value in register 312 is shifted towards the right 3 bits and the remaining 5 G bits are output to register 314. To accomplish this, register 314 is shifted towards the left to the 5<sup>th</sup> bit position. The B value is shifted towards the right 3 bits and the remaining B bits are output to register 314. As a result, the combined 16-bit color value has 6 R bits, 5 G bits, and 5 B bits.

[29] Figure 5 is an exemplary view illustrating an image converting process when G has a comparatively greater specific gravity. When G has the comparatively greater specific gravity, the 8-bit RGB values for each pixel in the 24-bit image are converted into a combined 16-bit RGB, with the extra 1 bit allocated to the G value. This may be described as  $R_{16}=R/8$ ,  $G_{16}=G/4$  and  $B_{16}=B/8$ .

[30] In the conversion process, a combined 16-bit color value for each pixel is formed by shifting the R value in register 411 towards the right 3 bits and then outputting the remaining 5 R bits to register 414. To accomplish this, register 414 is shifted towards the left to the 11<sup>th</sup> bit position. The G value in register 412 is shifted toward the right 2 bits and the remaining 6 G bits are output to register 414. To accomplish this, register 414 is shifted toward the left to the 5<sup>th</sup> bit position. The B is shifted towards the right 3 bits and the remaining 5 B bits are output to register 414.

[31] Figure 6 is an exemplary view illustrating an image converting process when B has a comparatively greater specific gravity. When the B has the comparatively greater

specific gravity, the 8-bit RGB values for each pixel in the 24-bit image are converted into a combined 16-bit RGB value, with the extra 1 bit allocated to B. This may be described as  $R_{16}=R/8$ ,  $G_{16}=G/8$  and  $B_{16}=B/4$ .

[32] In the conversion process, a combined 16-bit color value for each pixel is formed by shifting the R value in register 511 toward the right 3 bits and then outputting the remaining 5 R bits to register 514. To accomplish this, register 514 is shifted towards the left to the 11<sup>th</sup> bit position. The G value is shifted towards the right 3 bits and the remaining 5 G bits in register 512 are output to register 514. To accomplish this, register 514 is shifted towards the left to the 6<sup>th</sup> bit position. The B value in register 513 is shifted toward the right 2 bits and the remaining 6 bits are output to register 514.

[33] The above-mentioned processes for forming 16-bit RGB values for a 24-bit color image on a pixel-by-pixel basis are performed by the shift unit 330. Accordingly, the finally generated image containing the converted 16-bit RGB values is stored in the video memory 650. Afterward, the 16-bit RGB image may be transmitted to a display apparatus such as a LCD, etc. and is displayed as an image similar to an actual image.

[34] In the foregoing exemplary embodiments, the present invention has been described as determining color for a 16-bit image that has been converted from a 24-bit image. While this is an especially advantageous application of the present invention, those skilled in the art can appreciate that the invention may be used to express color for other-size image conversions, e.g., in an N-bit size color image converted from an M-bit size image, when  $M>N$ .

[35] The present invention thus improves the conventional 5:6:5 method in terms of color accuracy and process efficiency by allocating more (e.g., 6) bits to a color having a comparatively greater specific gravity than the bits allocated to represent the other colors. As a result, through the present invention a 16-bit image more similar to an actual image can be displayed on a mobile communication terminal. Accordingly, by applying the present invention to, for example, a mobile communication terminal to display 16-bit color, a more distinctive image can be provided to a user.

[36] In addition, it is possible to use both a method for varying conversion according to the greatest value by comparing a RGB value of each color value and a method for converting all color data according to the greatest value by calculating all RGB values of a whole image simultaneously.

[37] As the present invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, it should also be understood that the above-described embodiments are not limited by any of the details of the foregoing description, unless otherwise specified, but rather should be construed broadly within its spirit and scope as defined in the appended claims, and therefore all changes and modifications that fall within the metes and bounds of the claims, or equivalence of such metes and bounds are therefore intended to be embraced by the appended claims.